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THE ANTICOSTI ISLAND FAUNAS

by

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By W. H. Twenhofel.

INTRODUCTION.

The study of the Anticosti Island section was undertaken by the writer in the summer of 1909, the field work being done under the auspices of Peabody Museum of Yale University. The results derived from the field work and the preliminary study of the collections, were presented by Schuchert and Twenhofel at the Boston Meeting of the Geological Society of America and, later, published in the Bulletin of the Society. Subsequently the Geological Survey of Canada generously assumed the expense connected with the study of the faunas and a memoir will ultimately be published in which the palæontology and everything pertaining to the geology will be exhaustively treated. The many questions arising from the study of the faunas have made further field work desirable, if not actually necessary, and this will be undertaken before final publication, although the manuscript and plates of the work as originally planned are now completed. In the meantime, it has not appeared wise that the information gained and the conclusions reached should be withheld and the present paper is an attempt to give a summary of the chief results. It is hoped that their publication will elicit comment and give the writer the benefit of suggestion and advice

from other workers in equivalent strata. Throughout the entire study of the collections the writer has had the critical advice of Professor Charles Schuchert and the generous co-operation of the officers and scientists of the Geological Survey of Canada. Doctor R. S. Bassler assumed the study of the bryozoa and ostracoda and the identifications of all such species are his. A large number of other scientists have given advice and assistance. To them acknowledgment will be made in the final publication.

The study of the Anticosti faunas and the section have developed five facts of importance. They are as follows: (1) Billings' statement that the section is complete from base to summit and contains no stratigraphic break is sustained; (2) many of the species have ranges through greater thicknesses than the same species have in other regions; (3) the faunas of the north and south shores show great differences which in every instance correspond to differences in lithology and hence to differences in the ecologic conditions at the time of sedimentation; (4) the section is much thicker on the north shore than on the south, contains fewer corals and no coral reefs, and the sediments are less calcareous, but far more shaly and sandy; (5) the rocks of the Anticosti section once extended far inland on the Laurentides and much higher rock once overlay the highest rocks now present.

The absence of stratigraphic breaks in part explains the long vertical ranges of many of the species, since they occur in the strata which are wanting in equivalent sections of other regions.

While the faunas of the north and south shores are markedly different in many of the zones, it is also true that they are almost absolutely identical in those zones wherein the sediments of both shores are the same. These faunal differences are rendered more conspicuous by the absence on one shore of species to which great diagnostic value has been given, but which are present on the other shore. One of the most striking examples of this fact is the presence of *Rhynchotrema perlamellosa* in great abundance and with a considerable range in the northern outcrops of the Charleton formation, while to date no collector has obtained a single specimen of this species from the south shore, although the equivalent beds are most certainly exposed and less than twenty

miles separates the two outcrops. The number of such species is quite large and will be given in the final work. These faunal differences of the two shores leads to the conclusion that the faunas of the Anticosti seas were at least partly controlled by the depth of water and the character of the sediments. There is nothing new or strange in this conclusion since similar conditions always obtain in the case of modern waters. The fact, however, has great importance in correlation; but by many writers it appears to have been almost wholly ignored and differences of fauna have been explained in other ways. Exhaustive treatment of this phase of the stratigraphy is ultimately contemplated.

Anticosti island consists of a part of a cuesta on an ancient coastal plain which probably began to develop in the Devonian and existed until the time of the post-glacial submergence. It will be called the Anticosti cuesta. About twenty miles to the north the Mingan islands fringe the Quebec shore and consist of the remnants of a parallel cuesta. This will be named the Mingan cuesta. Between the two cuestas lay an inner lowland which near the west end of Anticosti was crossed by a north-south divide from which streams drained east and west, the former being the longer. North of the Mingan cuesta is another lowland. The latter will be called the Laurentide lowland and the former the Channel lowland.

FAUNAL SUMMARY OF THE SECTION.

Introduction.

The lithic characters of the zones were given in the earlier paper[1] and repetition at this time is unnecessary. The complete faunas of each formation will be given, but not zonally.

Two systems are represented in the Anticosti Island succession; Ordovician and Silurian. The basal division of the Anticosti Ordovician cannot be seen in place; but fragments in the shore material for about fifteen miles on the western end of the north shore show its presence at no great depth below the surface of the water. Since the material is most abundant and in the largest pieces near the buried divide of the Channel lowland, it is probable that the parent rock outcrops over a considerable extent on this ridge. It has been called the Macasty black shale The rock consists of a soft, highly bituminous black shale and carries a small biota of five species as follows: *Climacograptus spiniferus*, *C. typicalis magnificus*, *Leptobolus insignis*, *Triarthrus becki macastyensis* and *Orthoceras?* sp. Both lithology and fauna are in harmony with a correlation with the Utica as developed at Ottawa and elsewhere in eastern Canada.

Ordovician System, Richmond Series.

English Head Formation. The lowest rocks of this formation meet the waters of the North channel at the edge of the reef near English head on the northwest end of the island, and the summit is placed at the top of the so-called "track bed", a bed marked by peculiar impressions which Billings considered as probably the tracks of cephalopods. The fauna consists of one hundred and seven species of which seventy-nine pass into higher formations. Brachiopods are the most numerous, both in species and individuals, with the gastropods vying with them in each

[1] Schuchert and Twenhofel, Bull. Geol. Soc. Am., Vol. 21, 1910.

respect. The latter have an aspect somewhat more ancient than is generally found in equivalent strata, but as they are associated with many typical Richmond species, they are considered survivors of older deposits and given little weight. The formation has a thickness of 229 feet. The complete fauna of the formation is as follows:—

1	Lycrophycus	formosum
2	L.	robustum
3	L.	vagans
4	Særichnites	abruptus
5	Rauffella cf.	filosa
6	Calapœcia	canadense
7	Mesograptus	putillus
8	Paleofavosites	aspera
9	Streptelasma	angulatum
10	S.	rusticum
11	Periglyptocrinus	sp.
12	Cornulites	flexuosus
13	Arthroclema	angulare
14	Dianulites	n. sp.
15	Dicranopora	fragilis
16	Phacelopora	pertenuis
17	Ptilodictya	magnifica
18	P.	whiteavesi
19	Sceptropora	facula
20	Catazyga	anticostiensis
21	Dalmanella meeki	testudinaria
22	Dinobolus	n. sp. l.
23	Dinorthis	n. sp.
24	Hebertella	maria
25	Leptaena ?	ceres
26	L. ?	nitens
27	Lingula	forbesi
28	Parastrophia	lenticularis
29	Pholidops	n. sp.
30	Plectambonites	sericeus
31	Protozeuga	anticostiana
32	Pseudolingula	elegantula
33	Rafinesquina	n. sp.
34	Rhynchotrema	anticostiensis
35	R.	perlamellosa
36	Strophomena	fluctuosa
37	S.	hecuba
38	S.	n. sp.
39	Trematis	ottawaensis n. var.
40	Zygospira	recurvirostra n. var.
41	Byssonychia	n. sp.
42	Cyrtodonta	anticostiensis
43	C.	harrietti
44	C. ?	insularis
45	Pterinea	bellilineata
46	P.	prolifica
47	Rhytimya	emma
48	Vanuxemia	ungulata
49	Whitella	plebia
50	W.	sigmoidea
51	Archinacella	estella
52	Bellerophon ?	fraternus
53	B. ?	miser
54	B. ?	solitarius
55	B. ?	n. sp.
56	Clathrospira	subconica
57	Hormotoma	gracilis
58	Liospira	americana
59	Lophospira ?	circe
60	L. ?	modesta
61	L. ?	varians
62	Metoptoma ?	alceste
63	Oxydiscus	n. sp.
64	Palæacmæa	n. sp.
65	Phragmolites	desiderata
66	P.	pannosa
67	Raphistoma	n. sp.
68	Salpingostoma	canadensis
69	Sinuites cf.	bilobata
70	Trochonema	umbilicata
71	Conularia	asperata
72	Pterotheca	n. sp.
73	Actinoceras	anticostiensis
74	A.	sedgwicki
75	Apsidoceras	magnificum
76	Ascoceras	n. sp.
77	Billingsites	canadense
78	B.	newberryi
79	Cycloceras	crocus
80	C. cf.	nicolleti
81	Endoceras	proteiforme
82	Orthoceras	seiboldi
83	Poterioceras	obesum
84	Spyroceras	bilineatum
85	S.	ferum
86	Triptoceras	xiphius
87	Bollia	semilunata
88	Bythocypris	lindstrœmi
89	B.	obtusa
90	Krausella	anticostiensis
91	Macrocypris	subcylindrica
92	Schmidtella	sublenticularis
93	Amphilichas	n. sp.

94	Brachyaspis	altilis	100	Encrinurus	multisegmentatus
95	B.	notans	101	Eoharpes	ottawaensis
96	Bumastes	orbicaudatus	102	Isotellus	gigas
97	Ceraurus	numitor	103	I. cf.	maximus
98	C.	pleurexanthemus	104	Pterygometypus	n. sp.
99	Ceraurinus	icarus	105	Ischyrina	winchelli

Charleton Formation. The English Head formation is succeeded without lithologic or stratigraphic break by the Charleton formation. The faunas are likewise continuous and typical Richmond species which are introduced in the former become exceedingly abundant in the latter. A fact of some importance for geography and stratigraphy is the greatly increased thickness of the formation in the northern outcrops, the thickness of the south shore consisting of 730 feet, while that of the north exceeds 900 feet. The lithology of the north shore is also quite different from that of the south, the latter consisting largely of limestones and shales with the former predominating, while on the north shore shales are far more important and toward the top much sand is present, although a real sandstone is not developed.

Corals which occur quite commonly in the English Head formation, here become abundant, particularly on the south side, where heads of nearly three feet diameter occur. Through a considerable thickness near the middle of the formation the peculiar hydroid, Beatricia, lies around on the reef like logs in a swamp, or, slightly salient in the cliffs, projects like guns from a battery. Gastropods are not nearly so important as in the English Head, while the brachiopods play a greater rôle. The complete fauna consists of one hundred and sixty species of which seventy-five have come from the English Head. Sixty species are confined to the formation and fifty-six pass into succeeding formations, twenty-eight of which have come from the English Head. The species of the formation are:—

1	Lockeia	n. sp.	8	Calapœcia	canadense
2	Lycrophycus	vagans	9	Columnaria	alveolata
3	Rusophycus	bilobatum	10	Halysites	catenulatus
4	Hindia	fibrosa	11	Lyellia	affinis
5	Rauffella cf.	filosa	12	Lyopora	goldfussi
6	Beatricia	nodulosa	13	Paleofavosites	aspera
7	B.	undulata	14	P.	aspera n. var.

15	Streptelasma	angulatum
16	S.	rusticum
17	Zaphrentis	affinis
18	Carabocrinus	? tuberculatus
19	Cupulocrinus	latibranchiatus
20	Dendrocrinus	? tener
21	Hudsonaster	rugosus
22	Pleurocystites	anticostiensis
23	Retiocrinus	fimbriatus
24	Cornulites	flexuosus
25	C.	richmondensis
26	Arthroclema	angulare
27	Batostoma	n. sp.
28	Bythopora	striata
29	Chasmatopora	granistriata
30	Corynotrypa	dissimilis
31	Cyphotrypa	bulbosa
32	C.	n. sp.
33	Dicranopora	emacerata
34	D.	fragilis
35	Eridotrypa	simulatrix
36	Glauconema	strigosa
37	Goniotrypa	bilateralis
38	Hallopora	n. sp. 1.
39	H.	n. sp. 2.
40	Helopora	imbricata
41	Homotrypa	n. sp.
42	Lioclemella	nitida
43	Mitoclema ?	n. sp.
44	Nematopora	lineata
45	Pachydictya	firma
46	P.	hexagonalis
47	Prasopora	n. sp.
48	Protocrisina	exigua
49	Ptilodictya	canadensis
50	P.	flagellum
51	P.	magnifica
52	P.	whiteavesi
53	Rhinodictya	nitidula
54	Sceptropora	facula
55	Catazyga	anticostiensis
56	Chonetes	primigenius
57	Clitambonites	verneuili diversus
58	Crania	n. sp.
59	Dalmanella	testudinaria meeki
60	Dinobolus	n. sp. 1
61	Dinorthis	n. sp.
62	Eichwaldia ?	anticostiensis
63	Hebertella	maria
64	Hyattidina	charletona
65	Leptæna	? ceres
66	L.	? nitens
67	L.	? reticulata
68	L.	? n. sp.
69	Lingula	? canadensis
70	L.	? forbesi
71	Orthis	davidson in. var.
72	Parastrophia	lenticularis
73	Pholidops	n. sp.
74	Plectambonites	sericeus
75	Protozeuga	anticostiana
76	Pseudolingula	elegantula
77	Rafinesquina	n. sp.
78	Rhipidomella	sola
79	Rhynchotrema	anticostiensis
80	R.	perlamellosa
81	Schizocrania	filosa
82	Schuchertella	pecten
83	Strophomena	antiquata
84	S.	? arethusa
85	S.	fluctuosa
86	S.	hecuba
87	S.	n. sp.
88	Trematis	ottawaensis n. var.
89	Zygospira	recurvirostra n. var.
90	Byssonychia	n. sp.
91	Ctenodonta	cf. obliqua
92	Cyrtodonta	anticostiensis
93	C.	harrietti
94	Pterinea	bellilineata
95	P.	prolifica
96	P.	varistriata
97	Rhytimya	emma
98	Whitella	plebia
99	W.	sigmoidea
100	Bellerophon	n. sp.
101	Clathrospira	subconica
102	Cyclonema	thalia
103	C.	n. sp.
104	Hormotoma	gracilis
105	H.	multivolvis
106	H.	teretiformis
107	Liospira	americana
108	L.	n. sp.
109	Lophospira	modesta
110	L.	n. sp. 1.
111	L.	n. sp. 2.
112	Phragmolites	pannosa
113	Raphistoma	n. sp.
114	Salpingostoma	canadensis
115	Sinuites cf.	bilobata
116	Subulites	richardsoni
117	Conularia	splendida
118	C.	n. sp.
119	Pterotheca	n. sp.
120	Actinoceras	anticostiensis
121	A.	? fulgor
122	A.	sedgwicki
123	Billingsites	canadense
124	B.	newberryi
125	Cycloceras cf.	nicolleti
126	Cyrtoceras	n. sp.

127	Endoceras	proteiforme
128	Litoceras	hercules
129	Orthoceras	formosum
130	O.	lyelli
131	O.	magnisulcatum
132	O.	seiboldi
133	O.	n. sp.
134	Poterioceras	apertum
135	P.	obesum
136	Spyroceras	bilineatum
137	S.	ferum
138	Aparchites	minutissimus
139	Beyrichia	parallela
140	Bollia	semilunata
141	Bythocypris	cylindrica
142	B.	lindstrœmi
143	B.	obtusa
144	Ctenobolbina	hammelli
145	Krausella	anticostiensis
146	Primitia	lativa
147	Primitiella	canadensis
148	Schmidtella	sublenticularis
149	Tetradella	lunatifera
150	T.	simplex
151	Ulrichia	nodosa
152	Brachyaspis	alacer
153	B.	altilis
154	Bumastes	orbicaudatus
155	Calymmene	callicephala
156	Ceraurus	pleurexanthemus
157	Ceraurinus	icarus
158	Chasmops	n. sp.
159	Isotellus	gigas
160	I.	cf. maximus
161	Proetus	alaricus
162	Ischyrina	winchelli

Ordovician System, Gamachian Series.

Ellis Bay Formation. On the north shore the sandy shales of the Charleton formation give place without stratigraphic break to the basal Ellis Bay sands; but on the south shore the sequence is continued with limestones and shales, the latter becoming more important near the middle. The formation is excellently and extensively exposed in Ellis bay on the south shore and Prinstie bay on the north. On the south side the thickness is 180 feet, but in the northern outcrops it greatly exceeds this figure.

This formation is placed in a series distinct from the Richmond, the ground being taken that it is younger than any division assigned to that series. On the other hand it is considered older than any North American formation referred to the Silurian. The great number of Richmond species which continue into this formation and the total absence of any evidence for a break of any kind are considered good reasons for its retension in the Ordovician. It is to be noticed, however, that twenty-four of the twenty-six species of Charleton bryozoa become extinct with that formation and that of the twenty-two species of Ellis Bay bryozoa, twenty species are introduced with the Ellis Bay formation. Furthermore, the Ellis Bay bryozoa have their closest affinities with Silurian faunas, although fifteen of the species become extinct within the formation.

The fauna is one of the largest of any of the island's formations and nearly every species is represented by numerous individuals, although their vertical ranges are generally not extensive. Near the top occurs the first coral reef of the Anticosti section, but it is found only in the southern outcrops. It is about ten feet thick and formed almost wholly of *Paleofavosites*, *Lyellia*, and *Halysites*. On the present wave cut reef the coral masses rise as small mounds and in the cliffs the reef appears as a structureless mass with the superjacent beds overarching it, giving rise to an appearance of folding. Also near the top, but below the coral reef, is the second *Beatricia* zone and here they are equally as numerous as in the Charleton zone. The total fauna consists of one hundred and forty-two species of which thirty-five originate in the English Head formation and twenty-three in the Charleton. Fifty-eight species are confined to the formation and one hundred and seven species—nearly eighty per cent of the fauna—become extinct therein. The species are:—

1	Cyclocrinites	halli
2	Ischadites	? insularis
3	Hindia	fibrosa
4	Rauffella cf.	filosa
5	Beatricia	nodulosa
6	B.	undulata
7	Calapœcia	canadense
8	Clathrodictyon	vesiculosum
9	Columnaria	alveolata
10	Dictyonema	n. sp. (doubtful as to its having been collected here)
11	Favosites	forbesi
12	Halysites	catenulatus
13	Lyellia	affinis
14	L.	exigua
15	L.	speciosa
16	Mastigograptus	cf. simplex
17	Paleofavosites	aspera
18	P.	aspera n. var.
19	Protarea	tenuis
20	P.	vetusta
21	Streptelasma	selectum
22	Strombodes	diffluens (doubtful as to its having been collected here)
23	Zaphrentis	affinis
24	Z.	n. sp.
25	Cornulites	richmondensis
26	Allonema	botellus
27	Atactoporella	n. sp.
28	Ceramopora	niagarensis n. var.
29	Chasmatopora	angulata
30	Corynotrypa	dissimilis
31	Cyphotrypa	bulbosa
32	C.	polygona
33	Dianulites	n. sp.
34	Glauconema	strigosa
35	Hallopora	elegantula n. var.
36	H.	magnipora
37	Helopora	lineopora
38	Lichinalia	n. sp.
39	Lioclema	varioporum
40	Nematopora	lineata
41	Nicholsonella	parvula
42	Pachydictya	crassa
43	Phænopora	ensiformis
44	P.	excellens
45	Ptilodictya	gladiola
46	Stomotopora	siluriana
47	S.	arachnoidea
48	Atrypa	marginalis
49	Atrypina	n. sp.

50	Chonetes	primigenius
51	Clitambonites	verneuili diversus
52	Crania	n. sp.
53	Dalmanella	ruida
54	D.	testudinaria meeki
55	Dinobolus	n. sp. 1. n. var.
56	Dinorthis	anticostiensis
57	Hebertella	maria
58	Hindella	prinstana
59	H.	umbonata
60	Leptæna	rhomboidalis
61	L. ?	ceres
62	L. ?	nitens
63	L. ?	reticulata
64	L. ?	n. sp.
65	Lingula	forbesi
66	L.	insularis
67	Orthis	davidsoni n. var
68	O.	laurentina
69	O.	lamellosa
70	Parastrophia	lenticularis
71	P.	reversa
72	Pholidops	n. sp.
73	Platystrophia	dentata
74	P.	dentata n. var.
75	P.	fissicostata
76	Plectambonites	sericeus
77	Pseudolingula	elegantula
78	Rhipidomella	uberis
79	R.	uberis rhynchonelliformis
80	Rhynchotrema	anticostiensis
81	R.	janea
82	R.	n. sp.
83	Rhynchonella	? nutrix
84	Schuchertella	pecten
85	Strophomena	fluctuosa
86	S.	fluctuosa n. var.
87	S.	hecuba
88	S.	semiovalis
89	Trematis	ottawaensis n. var.
90	Byssonychia	n. sp.
91	Clionychia ?	superba
92	Ctenodonta	cf. simulatrix
93	Cuneamya	n. sp. 1
94	C.	n. sp. 2
95	Pterinea	striata
96	P.	varistriata
97	Vanuxemia	accutumbona
98	Bucania	n. sp.
99	Clathrospira	subconica
100	Cyclonema	thalia
101	Cyrtospira	notata
102	Diaphorostoma	humilis
103	Eccyliomphalus	n. sp.
104	Hormotoma	gigantea
105	H.	gracilis
106	Liospira	americana
107	L.	helena
108	L.	n. sp.
109	Lophospira ?	papillosa
110	L.	sybellina
111	L.	n. sp. 1
112	L.	n. sp. 2
113	Loxonema	rugosa
114	Oxydiscus	n. sp.
115	Palæacmæa	n. sp.
116	Phragmolites	desiderata
117	Salpingostoma	canadensis
118	Schizolopha	n. sp.
119	Sinuites cf.	bilobata
120	Subulites	richardsoni
121	S.	n. sp.
122	Tetranota cf.	obsoleta
123	Actinoceras	sedgwicki
124	Apsidoceras	magnificum ?
125	Billingsites	newberryi
126	Cycloceras	crocus
127	Oncoceras	fragile
128	Orthoceras	formosum
129	O.	seiboldi
130	Poterioceras	n. sp.
131	Brachyaspis	alacer
132	B.	notans
133	Bumastes	orbicaudatus
134	Calymmene	callicephala
135	Ceraurus	pleurexanthemus
136	Ceraurinus	icarus
137	Chasmops	truncato-caudatus
138	C.	n. sp.
139	Cyphaspis	n. sp.
140	Encrinurus	multisegmentatus
141	Isotellus	gigas
142	I. cf.	maximus
143	Sphaerocoryphe	salteri
144	Technophorus	plicata

Silurian System, Anticosti Series.

Becsie River Formation. The passage from the Ellis Bay to the Becsie River formation witnesses the extinction of about eighty per cent of the Ellis Bay fauna and the major portion of this extinction takes place in the upper three zones, which in their rapid lithic and faunal changes presage the initiation of a new geologic cycle; but beginning with the first zone of the Becsie River formation, stability of sedimentation and fauna is again instituted. Beyond the faunal evidence, there is none other, either structural or depositional, suggesting a stratigraphic break and the faunal change can not be taken to indicate any interruption of deposition, since it can as readily be explained by a change in ecology which may have been brought about by some physical event in a region comparatively distant, and until more is known of the factors that determine the characters of faunas, the causes of their local extinction and the replacement of one by another, it appears to the writer to be idle to assume that faunal changes are indicative of breaks unless they are accompanied by other evidence. Since no stratigraphic break has been ascertained, the base of the Becsie River formation and the Silurian has been somewhat arbitrarily placed where there is the most decided faunal and lithic change.

In the earlier paper by Schuchert and Twenhofel, the writers were inclined to the opinion that the early Silurian beds of Anticosti could be embraced within the series term Niagaran. This view has now been abandoned, since it appears that it would give the term too great an extension beyond its original application.

Savage has lately proposed the series term Alexandrian for certain early Silurian deposits of southwestern Illinois and eastern Missouri, the series to embrace all deposits between the Ordovician and the Clinton[1]. In 1857, Billings proposed to place all the Anticosti section above what is now defined as the Charleton formation in a new group which he proposed to call the Anticosti group, considering this portion of the Anticosti section as holding a position intermediate between the Ordo-

[1] Savage, Bull. Geol. Soc. Am., Vol. 24, 1913, p. 351.

vician (Hudson River beds) and the Niagara limestone.[1] It has since been learned that he erred in including too much, since the lowest division of his Anticosti group belongs to the Ordovician and the upper two divisions to the Clinton and higher formations (Niagaran). The future employment of Billings' term requires its emendation and it appears to the writer that this should be done, since Billings gave the term its proper significance, erring only in including too much, and also in that the Anticosti section is far more complete and hence far more representative of this time than any other on the North American continent. This course has been followed in the present paper. In the final paper the matter will be more adequately treated.

Silurian deposition was initiated by the formation of a yellowish-white limestone in which is recorded the almost complete disappearance of the species which had been so abundant in the Ellis Bay formation. The tabulate corals, however, form an exception, since they continue in almost undiminished numbers. The number of species decreases to thirty-nine, of which nineteen have come from below, consisting for the most part of the Anticosti and generally well-known long ranging corals and brachiopods. In the lower half of the formation the number of species is few and none is abundantly represented, but in the upper portion there are more species and most are extremely abundant in individuals. Nineteen of the thirty-nine species are brachiopods. The thickness of the formation is 188 feet. The species present are:—

1	Cyclocrinites	halli
2	Clathrodictyon	vesiculosum
3	Cyathophyllum	wahlenbergi
4	Diphyphyllum	cæspitosum
5	Favosites	forbesi
6	F.	gothlandicus
7	Halysites	catenulatus
8	Lyellia	affinis
9	Paleofavosites	aspera
10	Zaphrentis	stokesi
11	Helopora	concava
12	H.	formosa
13	Pachydictya	crassa
14	Phænopora	superba
15	Ptilodictya	gladiola
16	Atrypa	marginalis
17	Brachyprion	leda
18	B.	n. sp.
19	Camarotœchia	neglecta
20	Clorinda	undata n. var.
21	Cœlospira	planoconvexa
22	Crania	n. sp.
23	Hindella	prinstana
24	H.	umbonata
25	Orthis	davidsoni n. var.
26	O. ?	flabellites
27	Parastrophia	lenticularis

[1] Billings, Rept. Progress 1853-1856, Geol. Surv. of Canada, 1857, p. 250.

28	Platystrophia	dentata
29	Rhipidomella	uberis
30	R.	uberis rhynchonelliformis
31	Schuchertella	pecten
32	Virgiana	barrandei
33	V.	barrandei n. var.
34	V.	n. sp.
35	Bumastes	orbicaudatus
36	Calymmene	callicephala
37	C.	niagarensis
38	Cyphaspis	n. sp.
39	Illænus	grandis

Gun River Formation. Corals play a greater rôle in the Gun River than in any previous formation, but the common species are the same as those of lower horizons. Two large reefs occur in the southern outcrops, one at St. Ann cliff and the other at East cliff. They are not, however, in the same horizon and there is none on the north side. Fossils are abundant in almost every zone and the vertical range of each species is generally quite extensive. The total fauna consists of one hundred and thirty species of which forty-eight are brachiopods and these constitute fully eighty per cent of the individuals. Of the entire fauna eighty-seven originate in this formation and forty-four are derived from lower horizons. The formation has a thickness of 500 feet. The species are:—

1	Buthotrephis	cf. gracilis
2	Rusophycus	bilobatum
3	Cyclocrinitis	gregarius
4	C.	intermedius
5	Ischadites	kœnigi
6	Aulopora cf.	precius
7	Clathrodictyon	vesiculosum
8	Climacograptus	typicalis n. var.
9	Cyathophyllum	euryone
10	C.	wahlenbergi
11	Cystiphyllum	niagarense
12	Diphyphyllum	cæspitosum
13	Favosites	forbesi
14	F.	gothlandicus
15	Halysites	catenulatus
16	Heleolites	subtubulata
17	Lyellia	affinis
18	Paleofavosites	aspera
19	P.	aspera n. var.
20	Petraia	pygmea
21	Streptelasma	latusculum
22	Strombodes	diffluens
23	Syringopora	verticillata
24	Zaphrentis	stokesi
25	Z.	n. sp. 1
26	Z.	n. sp. 2
27	Cornulites	richmondensis
28	C.	serpularius
29	Allonema	curtum
30	Ascodictyon	n. sp.
31	Ceramopora	niagarensis n. var.
32	Corynotrypa	dissimilis
33	C.	elongata
34	Diploclema	sparsum
35	Helopora	bellula
36	H.	concava
37	H.	formosa
38	H.	lineopora
39	Pachydictya	crassa
40	Phænopora	ensiformis
41	P.	excellens
42	P.	superba
43	P.	n. sp.
44	Ptilodictya	gladiola
45	P.	sulcata
46	Semnocoscinium	n. sp.
47	Vinella	radiciformis
48	Atrypa	reticularis
49	Bilobites	biloba
50	Brachyprion	leda
51	B.	philomena
52	B.	n. sp. 1

53	B.	n. sp. 2	88	Triplecia	insularis n. var.
54	B.	n. sp. 3	89	Whitfieldia	? lara
55	Camarotœchia	decemplicata	90	W.	? solitaria
56	C.	fringilla	91	Zygospira	paupera
57	C.	glacialis	92	Z.	n. sp.
58	C.	neglecta	93	Pterinea	emacerata
59	C.	? pyrrha	94	P.	striata
60	Chonetes	primigenius	95	P.	thisbe
61	Clorinda	linguifera	96	P.	n. sp.
62	Cœlospira	hemispherica	97	Cyclonema	bellula
63	C.	planoconvexa (zone 1 only)	98	Diaphorostoma	humilis
			99	D.	niagarensis
64	Dalmanella	n. sp.	100	Euomphalus	? n. sp.
65	Hebertella	n. sp.	101	Hormotoma	? aculeata
66	Hindella	umbonata	102	H.	? funata
67	Homeospira	n. sp.	103	Pleurotomaria	? cryptata
68	Hyattidina	congesta junea	104	Salpingostoma	n. sp.
69	Leptæna	rhomboidalis	105	Tentaculites	cf. minutis
70	Orthis	davidsoni n. var.	106	T.	ornatus
			107	Actinoceras	infelix
71	O.	? flabellites	108	Huronia	persiphonatum
72	Pentamerus	oblongus	109	Kionoceras	bellatulum
73	Pholidops	implicata	110	Orthoceras	raptor
74	Platystrophia	dentata	111	Beyrichia	parallela
75	Plectambonites	transversalis	112	Eurychilina	billingsi
76	P.	n. sp.	113	Leperditia	anticostiensis
77	Rhipidomella	uberis	114	Bumastes	orbicaudatus
78	R.	uberis rhyncho-nelliformis	115	Calymmene	niagarensis
			116	C.	cf. vogdesi
79	Rhynchonella	? nutrix	117	Cheirurus	nuperus
80	Schuchertella	alterniradiata	118	Dalmanites	caudatus n. var.
81	S.	pecten	119	Encrinurus	punctatus
82	Stricklandinia	brevis	120	E.	punctatus n. var.
83	S.	davidsoni			
84	S.	lirata	121	Illænus	grandis
85	S.	salteri	122	Lichas	canadensis
86	Strophomena	antiquata	123	Phacopidella	orestes
87	Strophoprion	geniculatum			

Jupiter River Formation. With progress upward the Gun River formation becomes more shaly and this culminates in the second zone of the Jupiter River formation which is almost entirely so, though carrying a small proportion of sand. Following the shale zone the sediments become more calcareous. The above statements apply only to the western outcrops of the south shore. In the eastern outcrops, both the upper Gun River and the Jupiter River formations consist of alternating shales and limestones. The thickness in the western outcrops is 562 feet, that in the eastern is unknown.

In the western outcrops the ecologic conditions at the time of deposition provided a facies favourable for graptolites and tri-

lobites and such are present in considerable abundance. The fauna consists of one hundred and forty-seven species of which forty-six are brachiopods. Sixty-five species are introduced in the formation and one hundred and twelve species do not appear in the succeeding division. The apparently local extinction of this great number of species has no great significance since it was probably determined by the entrance of the reef coral-crinoid faunas which were in complete possession of the parts of the Anticosti sea bottom whose preserved deposits now constitute the Chicotte formation. To what factors these faunas owe their entrance cannot be said and speculation appears idle. The species of the Jupiter River formation are:—

1	Buthotrephis	cf. gracilis	39	F.	n. sp. 2
2	Hyalostelia	? n. sp.	40	Helopora	bellula
3	Alveolites	labechi	41	H.	concava
4	Chonophyllum	canadense	42	H.	formosa
5	Clathrodictyon	variolare	43	Lioclema	varioporum
6	C.	vesiculosum	44	Pachydictya	crassa
7	Climacograptus	n. sp.	45	Phænopora	n. sp.
8	Cœnites	labrosus	46	Ptilodictya	gladiola
9	C.	lunatus	47	P.	sulcata
10	Cyathophyllum	anticostiense	48	Thamniscus	n. sp.
11	C.	n. sp.	49	Trematopora	irregularis
12	Cystiphyllum	niagarense	50	Vinella	multiradiata
13	Dictyonema	n. sp.	51	V.	radiciformis
14	Favosites	favosus	52	Atrypa	reticularis
15	F.	forbesi	53	Bilobites	biloba
16	F.	gothlandicus	54	Brachyprion	leda
17	F.	hisingeri	55	B.	philomena
18	Halysites	catenulatus	56	B.	n. sp. 1
19	Heleolites	interstincta	57	B.	n. sp. 2
20	H.	subtubulata	58	Camarotœchia	? argentea
21	Lyellia	affinis	59	C.	decemplicata ?
22	Monograptus	clintonensis	60	C.	glacialis
23	Paleofavosites	aspera	61	C.	neglecta ?
24	Petraia	pygmea	62	Chonetes	primigenius
25	Plasmopora	petalliformis	63	Clorinda	linguifera
26	Streptelasma	latusculum	64	Cœlospira	hemispherica
27	Syringopora	verticillata	65	Crania	n. sp.
28	Zaphrentis	patens	66	Dalmanella	elegantula media
29	Z.	stokesi	67	D.	n. sp.
30	Z.	n. sp.	68	Eospirifer	radiatus
31	Crotallocrinus	sp.	69	Homeospira	n. sp.
32	Eucalyptocrinus	sp.	70	Leptæna	julia
33	Cornulites	serpularius	71	L.	rhomboidalis
34	Allonema	botellus	72	Lingula	n. sp. 1
35	Ascodictyon	n. sp.	73	L.	n. sp. 2
36	Chilotrypa	circe	74	Lissatrypa	atheroidea
37	Diploclema	sparsum	75	Orthis	? flabellites
38	Fenestella	sp. 1	76	Pentamerus	oblongus

77	Pholidops	implicata
78	Plectambonites	transversalis
79	P.	n. sp.
80	Rhipidomella	uberis
81	R.	uberis rhynchonelliformis
82	Rhynchonella	? nutrix
83	Schuchertella	pecten
84	Stricklandinia	brevis
85	S.	davidsoni
86	S.	davidsoni n. var
87	S.	lirata
88	S.	melissa
89	S.	salteri
90	S.	n. sp.
91	Strophomena	antiquata
92	Strophoprion	geniculatum
93	Triplecia	insularis n. var.
94	Whitfieldia ?	julia
95	W. ?	lara
96	Zygospira	mica
97	Z.	paupera
98	Conocardium	elegantulum
99	Ctenodonta	cf. socialis
100	Modiolopsis	miser
101	Mytilarca	cf. mytiliformis
102	M.	nitida
103	Pterinea	curiosa
104	P.	emacerata
105	P.	striata
106	P.	thisbe
107	Cyclonema	communis
108	C.	percingulata
109	Diaphorostoma	humilis
110	D.	niagarensis
111	Hormotoma	? aculeata
112	H.	? funata
113	H.	? turricula
114	Holopea	mediocris
115	Pleurotomaria	? cryptata
116	Salpingostoma	n. sp.
117	Conularia	niagarensis
118	Tentaculites	cf. minutis
119	T.	ornatus
120	Actinoceras	infelix
121	A.	whitei
122	Glossoceras	? desideratum
123	Huronia	persiphonatum
124	H.	vertebralis
125	Kionoceras	bellatulum
126	Oncoceras	futile
127	Orthoceras	n. sp. 1
128	O.	n. sp. 2
129	Aparchites	minutissimus
130	Beyrichia	venusta
131	Eurychilina	billingsi
132	Leperditia	anticostiensis
133	L.	frontalis
134	Macrocypris	subcylindrica
135	Calymmene	niagarensis
136	C.	cf. vogdesi
137	Cheirurus	nuperus
138	Cyphaspis	christyi
139	Cybele	elegantulus
140	Dalmanites	caudatus n. var.
141	Encrinurus	punctatus
142	E.	punctatus n. var.
143	E.	n. sp.
144	Illænus	grandis
145	Lichas	n. sp.
146	Phacopidella	orestes
147	Proetus ?	perplexa

Chicotte Formation. The Chicotte facies was one favouring the development of reef corals and crinoids and the entrance of these faunas and the ecologic conditions to which the entrance was due, drove the mud loving animals of the Jupiter River to extinction or to other parts of the sea bottom. The thickness of the formation is 73 feet, the greater part of which consists of either a structureless mass of corals plastered over each other, or a breccia formed of the broken stems of crinoids. In some places the rock is so highly crystalline as to constitute a marble.

The fauna consists of fifty-two species of which nineteen are introduced in the formation. This is the only one of the Anticosti formations in which the corals outnumber the brachiopods in species and individuals; in respect to species the ratio is

two to one and in respect to individuals there is no comparison. The species are:—

1	Chonophyllum	canadense
2	Clathrodictyon	variolare
3	C.	vesiculosum
4	Cœnites	labrosus
5	Cyathophyllum	anticostiense
6	C.	articulatum
7	Favosites	favosus
8	F.	forbesi
9	F.	gothlandicus
10	F.	hisingeri
11	Halysites	catenulatus
12	Heleolites	interstincta
13	H.	megastoma
14	H.	subtubulata
15	Lyellia	affinis
16	L.	americana
17	Paleofavosites	aspera
18	Plasmopora	petalliformis
19	Zaphrentis	stokesi
20	Z.	n. sp.
21	Crotallocrinus	sp.
22	Fenestella	bella
23	Pachydictya	crassa
24	Atrypa	marginalis
25	A.	reticularis
26	Camarotœchia	vicina
27	Cyrtia	exporrecta myrtea
28	Dalmanella	elegantula media
29	Eospirifer	radiatus
30	Leptæna	rhomboidalis
31	Parastrophia	ops
32	Pentamerus	oblongus
33	Rhipidomella	uberis
34	Conocardium	elegantulum
35	Cyclonema	communis
36	C.	decora
37	C.	varians
38	Platyceras	niagarensis
39	Actinoceras	backi
40	A.	medon
41	Huronia	vertebralis
42	Oncoceras	amator
43	Orthoceras	bucklandi
44	O.	? pileolum
45	O.	n. sp.
46	Phragmoceras	n. sp.
47	Cheirurus	nuperus
48	Goldius	insularis
49	Harpes	consuetus
50	Illaenus	grandis
51	Pseudosphærexochus	canadensis

CORRELATION.

The English Head and Charleton formations are correlated directly with the whole of the Interior Richmond and are considered the almost exact time equivalents, the great number of species common to the two regions and the order of their vertical occurrence rendering the correlation practically positive and leading to the inference that direct and open communication prevailed between the two regions during the times of deposition of at least the upper portion of the English Head formation and the whole of the Charleton. The common species are:—

1	Rusophycus	bilobatum
2	Hindia	fibrosa
3	Beatricia	nodulosa
4	B.	undulata
5	Calapœcia	canadensis
6	Columnaria	alveolata
7	Lyopora	goldfussi
8	Mesograptus	putillus
9	Streptelasma	rusticum
10	Cornulites	richmondensis
11	Arthroclema	angulare
12	Bythopora	striata

13	Chasmatopora	granistriata
14	Dicranopora	emacerata
15	D.	fragilis
16	Eridotrypa	simulatrix
17	Helopora	imbricata
18	Lioclemella	nitida
19	Mitoclema	n. sp.
20	Pachydictya	firma
21	Phacelopora	pertenuis
22	Protocrisina	exigua
23	Ptilodictya	flagellum
24	P.	magnifica
25	Semocoscinium	pretiosa
26	Stomotopora	arachnoidea
27	Catazyga	anticostiensis
28	Clitambonites	verneuili diversus
29	Dalmanella	testudinaria meeki
30	Dinorthis	subquadrata n. sp.
31	Leptaena	rhomboidalis (appears in lower Ellis bay)
32	L.	? nitens
33	Platystrophia	dentata-acutilirata
34	Plectambonites	sericeus
35	Rhynchotrema	anticostiensis
36	R.	perlamellosa
37	Schizocrania	filosa
38	Strophomena	fluctuosa
39	Byssonychia	cf. radiata
40	Ctenodonta	cf. obliqua
41	Pterinea	prolificus-demissa
42	Hormotoma	gracilis
43	Sinuites cf.	bilobata
44	Aparchites	minutissimus
45	Beyrichia	parallela
46	Bythocypris	cylindrica
47	Tetradella	lunatifera
48	T.	simplex
49	Ulrichia	nodosa
50	Calymmene	callicephala
51	Ceraurus	pleurexanthemus
52	Ceraurinus	icarus
53	Isotellus	gigas
54	I.	cf. maximus

It is significant of the above list that it embraces some of the most common of the English Head and Charleton species, but that many common forms of the Interior are wanting. Since nearly all the forms considered belong to the benthos in adult life, but plankton in the early stages when distribution is affected by currents, it is suggested that the Anticosti Richmond forms are of North Atlantic origin and were carried into the Mississippian sea by westward trending currents which made it almost impossible for interior species to reach Anticosti.

One of the most striking examples of the parallelism between the Richmond faunas of the Interior and those of Anticosti is that afforded by the outcrops at Stony mountain in Manitoba, where out of a total of fifty-three identifiable forms, there are thirty which are present in the Anticosti rocks, and of these thirty species, no less than twenty-two are considered index fossils to the Richmond. The distribution of the species is also similar to that in the Anticosti beds, so that a correlation can be made with zones 3, 4, and 5 of the Charleton formation that is practically positive.

The faunas of the Ellis Bay formation are partly derivative from those of the previous formations, partly indigenous, and partly migrants from European seas. Most of the species consist of forms not elsewhere known in America, or not in a horizon so low as this. That there is a decided Richmond aspect is clearly evident; but the assemblage is not identifiable with that of any interior deposit. This suggests that the interior was free from marine waters, or that all paths permitting migration to the interior were closed. The former view is adopted and it is hence concluded that the Ellis Bay formation has no equivalent in North America.

The lack of recent comprehensive works on British stratigraphy and palæontology renders correlation with British sections difficult and this is particularly true for the English Head and Charleton formations; but the evidence indicates that these two formations find an equivalence high up in the Bala series. The Ellis Bay formation contains eleven species which are also found in the English Bala, of which seven are considered diagnostic by reason of their first appearance or limited vertical distribution, and a correlation based on the common presence of these species would assign at least the lower portion of the Ellis Bay to the upper Bala.

In the Kristiana region of Norway, the Ordovician and Silurian have lately been exhaustively studied by Professor Kiaer. He erects a number of divisions and the Ellis Bay formation and the upper Charleton correlate fairly well with his etage 5.[1]

In Baltic Russia, the Lyckholm and Borkholm formations are the equivalents of the lower parts of the Ellis Bay and parts of the English Head and Charleton formations. The Borkholm carries eighteen species of great diagnostic value which in the Anticosti section occur chiefly in the Ellis Bay and Charleton formations, and it is considered that the Borkholm holds about the same stratigraphic position as the lower zones of the former and the higher of the latter.

The Becsie River fauna shows its nearest relationships with

[1] Kiaer, Videnskabs-Selskabets Skrifter, I, Math-Naturv. Klasse, bd. ii.

that of the cataract formation of Schuchert; but if the long ranging species be not considered, there are only three species common to the two formations, while most of the Cataract species make their first appearance in strata higher in the Anticosti section than the Becsie River formation, and, since the general expression of the Cataract formation is younger, it is concluded that there is little basis for equivalence and that the Cataract should probably be correlated with the lower portion of the succeeding formation.

A fauna holding a stratigraphic position somewhat similar to that of the Becsie River is that of the Alexandrian series of Illinois and eastern Missouri; but of the total fauna of that series, there are only nine species which also occur in the Anticosti section and, since they are mostly species of extended vertical distribution, their presence affords no basis for correlation. However, since four of the nine species do not appear in the Anticosti section until the upper zone of this, or the succeeding formation, and, also, since the general appearance of the fauna is younger than that of the Becsie River, it is believed that it will find a closer equivalence with the upper portion of this and some parts of the succeeding formation.

The highest zone of the Gun River formation shows the appearance of typical Clinton species, but the Clinton faunal assemblage does not attain full development until the succeeding Jupiter River. Since the Jupiter River fauna correlates best with the higher New York Clinton, the Williamson shale, and the Irondequoit limestone, this being particularly true for that part lying above zone 2, it is considered probable that the lower zones of the New York Clinton, the Sodus shale, Furnaceville ore bed, and Walcott limestone, find representation in the lowest zones of the Jupiter River and the highest zone of the Gun River, especially as the Walcott limestone carries the same diagnostic fossils as does zone 5 of the Gun River formation. It is further considered probable that the middle and lower zones of the Gun River formation are the Anticosti equivalents of the Cataract of southern Ontario and the Brassfield of the Ohio valley. An apparent reminder of the Brassfield appears in zone 5 of the Gun River formation in the occurrence of *Triplecia insularis anticostiensis* which then extends until zone 3 of the Jupiter River. In a previous

paper considerable emphasis was placed on the presence of this species[1], there considered a variety of *T. ortoni;* but further study has shown that it is specifically distinct from that species and only varietally different from the Old World *T. insularis.*

The Chicotte formation carries a pronounced coral fauna of which most of the species are those which are common in the coral zones of lower horizons. The writer does not consider that the stratigraphic position of the coral fauna means anything in relation to correlation, for the Anticosti section proves without question that coral deposits are not necessarily of great horizontal distribution and may recur again and again with the faunal components practically the same. On stratigraphic grounds it is correlated for the present with the Irondequoit-Rochester of the New York section.

Elsewhere in the Anticosti embayment there are extensive Silurian deposits; but they are either somewhat younger than those of Anticosti or present a different type of sedimentation. Thus the Black Cape section of Chaleur bay, recently described by Clarke[2], begins with what appears to be the probable equivalent of the upper Jupiter River or the Chicotte, while the Arisaig section begins with a black shale lithology with a corresponding faunal assemblage, the result being that few species are common to the two series or deposits. These indicate that the Arisaig section begins with the equivalent of the upper portion of the Gun River formation and then continues upward nearly to the Devonian.

In terms of the European section, stratigraphic grounds would assign the Becsie River and Gun River formations to the Lower Llandovery; but, excepting the upper zones of the Gun River, the fauna gives little support. The upper zones of the Gun River record the appearance of *Pentamerus oblongus, Clorinda liguifera, Coelospira hemispherica, Stricklandinia davidsoni* (represented in Europe by *S. lens*) which make their appearance in the Lower Llandovery, but become abundant in the Upper Llandovery. These and other species and their vertical

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[1] Schuchert and Twenhofel, Bull. Geol. Soc. Am., Vol. 21, 1911, p. 712.

[2] Clarke, Guide Book No. 1, pt. 1, International Geol. Congress, 1913, pp. 110-113.

distribution lead to the assignment of the upper zones to the Lower Llandovery and hence that which lies before has been similarly placed, although it is possible that the Becsie River may have no representation in the British section.

The greater portion of the Jupiter River formation is Upper Llandovery, in which no less than thirty-nine identical or closely related species of Jupiter River forms occur—nearly thirty per cent of the Jupiter River fauna. The vertical distribution of many of the species sustains the correlation. *Triplecia insularis* holds to the Upper Llandovery, and its Anticosti variety appears for the last time in zone 3 of the Jupiter River formation. *Pentamerus oblongus* is rare in the Gun River, but very abundant in the Jupiter River. In England it is rare in the Lower Llandovery, but abundant in the Upper Llandovery. Many other species show the same distribution.

The English Wenlock carries a large coral fauna and in this respect is like the Chicotte, but in the writer's judgment this resemblance has no correlative value, as the Anticosti section teaches that a coral reef formation may recur again and again and locally lie at many different horizons. The English Wenlock, however, has forty-nine species which have representation in identical or closely related forms in the Upper Jupiter River and Chicotte formations and these facts make it extremely probable that these Anticosti strata have a time equivalence with the Wenlock.

In the Kristiana region, the Silurian (Lower Llandovery to Wenlock) of the Ringerike section, there is a facies somewhat similar to that of Anticosti, and has thirty-seven species which are represented by identical or closely related forms in the Anticosti Silurian. The Lower Llandovery, Kiaer's etage 6, correlates fairly well with the Gun River and the upper portion of the Becsie River; while etage 7 or the Upper Llandovery, exhibits a close parallelism with the Jupiter River, and etage 8, or the Wenlock, shows close faunal equivalence with the upper Jupiter River and the Chicotte formations.

NEW GENERA AND SPECIES OF FOSSILS FROM ANTICOSTI ISLAND.

The postponement of publication of the complete faunas of the Anticosti Island section until the completion of further field work, is the excuse for the present appearance of the descriptions that are given on the pages which follow. Since one of the generic terms has already been referred to by Professor T. E. Savage[1] and there is a prospect that another will soon be used by another student, it has seemed desirable and wise that their definitions and those of a few others of the more important forms be given. Bibliographies will be omitted as far as possible, leaving this to the complete description of the faunas.

Phylum, COELENTERATA.
Class, HYDROZOA HUXLEY.
Order, GRAPTOLOIDEA LAPWORTH.
Suborder, AXONOPHORA FRECH.
Genus, CLIMACOGRAPTUS HALL.

CLIMACOGRAPTUS TYPICALIS *var.* MAGNIFICUS *n. var.*

A common form in the Macasty black shales is a giant variety of the *C. typicalis* group and to this the above varietal name has been applied. It has the same type of rhabdosome with the rapidly narrowing sicular end and the two sicular spines. The rhabdosome attains a width of at least 4 mm. and an unknown length, but at least 70 mm. There are eleven to fourteen thecae in 10 mm. It differs from *C. typicalis* in being longer and wider.

Horizon and Locality. Ordovician; the specimens were collected at Macasty bay from a large block of the Macasty shale. The writer has collected similar specimens of almost the same size from the Utica black shales on the banks of the Rideau river at Ottawa, Canada.

The holotype is in Peabody Museum, Yale University.

Class, ACTINOZOA.
Order, MADREPORARIA MILNE-EDWARDS.

[1] Savage, Bull. Geol. Soc. Am., Vol. 24, 1913, p. 359.

Sub-order, TABULATA MILNE-EDWARDS AND HAIME.
Family, FAVOSITIDAE MILNE-EDWARDS AND HAIME.
Genus, PALEOFAVOSITES *new genus*.

From the Ordovician and Silurian rocks of Anticosti, Billings described *Favosites prolificus* and *F. capax*, the latter having the pores at the angles and the former having none. It has since been learned that the two species are identical and also the same as *F. aspera* d'Orbigny and *F. alveolaris* Goldfuss, the four species having the common character of having the pores at the angles with none on the sides. It is proposed to include corals of this type under the above generic name. As thus defined the species will have for its genotype, *F. aspera* d'Orbigny. The only other form to be included is a new one to be described from the Anticosti section.

Phylum, MOLLUSCOIDEA.
Class, BRACHIOPODA DUMERIL.
Order, PROTREMATA BEECHER.
Super-family, ORTHACEA Walcott and Schuchert.
Genus, ORTHIS DALMAN (s. str.)
ORTHIS? LAMELLOSA *new species*.
(Plate I, figures 1–3)

Outline semielliptical, greatest width about halfway from beak to border where it is 8 mm.; 7 mm. wide at the hinge line; thickness 4 mm.; length 6 mm. Sides of the shell straight and almost parallel, gently and uniformly curving around the anterior-lateral margins; anterior margin for about half the width almost straight. Dorsal valve shallow with a broad mesial sinus, beak slightly incurved. Ventral valve pyramidal, beak highest portion, not incurved; no fold to correspond to the dorsal sinus; surface slopes uniformly from the beak to the anterior and lateral margins. The cardinal area as long as the hinge line, 2.5 mm. wide on the ventral valve, almost perpendicular to the plane of the lateral margins. Area of the dorsal valve less than 0.25 mm. wide and in the same plane as the lateral margins.

Foramen narrow, about 0.25 mm. wide, sides almost parallel, extends to the beak and finds its other continuation in the dorsal valve. Wetting of the ventral area shows that narrow side plates are annexed to the sides of the foramen; these are supposed to be continuous with the teeth, as in *O. bouchardi*, the nearest related species. These plates simulate deltidial plates with which, however, they are probably in no way homologous.

This species finds its nearest relative in *O. bouchardi* Davidson, from the Wenlock of England and Scotland, from which it differs in having no ventral sinus, the sides of the foramen parallel instead of converging to the beak, the ventral area making a right instead of an acute angle with the plane of the lateral margins, no longitudinal striations on the area such as exist in that species, and in being more finely plicate with all the plications reaching the beak. That species also has the ventral area curved and the beak incurved.

Horizon and Locality. Ordovician; Ellis bay in zone 5 of the Ellis Bay formation.

The holotype is in Peabody Museum, Yale University. Only a single specimen has been collected.

Superfamily, STROPHOMENACEA SCHUCHERT.
STROPHOPRIAN *new subgenus.*

The above subgeneric term is proposed for those resupinate forms of the Strophomenidae which are like *Strophonella* except that they have some ten or a dozen denticulations along the hinge line instead of a completely denticulated hinge margin. That is, these forms mark the inception of the *Strophonella* stock, *Strophoprion* holding the same relation to *Strophonella* that *Brachyprion* does to *Stropheodonta.* In one line of development there are *Strophomena—Strophoprion—Strophonella;* in the other *Rafinesquina—Leptaena?* (*ceres—nitens* stock, not *rhomboidalis*)—*Brachyprion—Stropheodonta.* The type of Strophoprion is *Strophoprion geniculatum* (Shaler) (*Brachyprion geniculatum* Shaler, Bull. Mus. Comp. Zool., vol. 1, No. 4, p. 63, 1865).

Genus, TRIPLECIA HALL.

TRIPLECIA INSULARIS *var.* ANTICOSTIENSIS *new variety.*

1871. Orthis insularis Davidson, Mon. Brit. Foss. Brach., vol. iii, pt. vii, p. 273, pl. xxxvii, figs. 8-15.
1910. Triplecia ortoni Schuchert and Twenhofel, Bull. Geol. Soc. Am., vol. 21, p. 710.

The discovery of this somewhat widely ranging north European species, in the lowest Clinton deposits of the Anticosti section, is a matter of considerable interest, since it has not previously been definitely recognized in America although its probable presence in the Anticosti rocks was mentioned by Davidson. It is somewhat larger than the European form and has a deeper ventral sinus.

Horizon and Locality. Silurian; Gun River (5), about a mile west of Jupiter River; Jupiter River (3), Jupiter river.

The holotype and plesiotypes are in Peabody Museum.

Genus, CHONETES FISHER.

CHONETES (EODEVONARIA) PRIMIGENIUS *new species.*

(Plate I, figures 4–5).

The shell of this new species closely resembles that of *Brachyprion leda* (Billings) and was at first mistaken for that species. Hinge line greatest width, average 9 to 12 mm., average length 6 to 8 mm. Ventral valve moderately convex, but not nearly so much so as in *Plectambonites*. In the Ellis Bay formation specimens were found attached by the dorsal valve to the shells of other brachiopods, but whether this has any significance or not is unknown. There are four small spines on each side of the beak. The surface of each valve is covered with numerous fine striæ—about one hundred and fifty to each valve—and in the centre of the ventral valve is a single striation very much stronger than any other, such as occurs in *Leptaena? nitens*, whose ventral interior that of this shell also closely resembles. The hinge area is striated as in *Brachyprion leda.* The dorsal interior is not known.

This is the earliest known appearance of this genus and since it is already a fully developed *Chonetes* it follows that it originated still earlier in the Ordovician. From its decided resemblance to *Brachyprion leda* it is extremely probable that both came from the same stock, viz.; a small leptaenoid ? with a narrow muscle scar, fine plications, and a single central plication of large size. In the Anticosti measures *Leptaena? nitens* answers to this description.

C. primigenius is smaller than the European *C. striatella* and more finely striate; it is larger than *C. cornutus* from the New York Clinton; it is about the same size and shape as *C. tenuistriatus* from the Arisaig Silurian, but that shell does not appear to have the prominent mid striation and is less finely striate.

Horizon and Locality. Ordovician and Silurian. The species first appears on the north side of Anticosti in zone 3 of the Charleton formation. Its next appearance is at Ellis bay in the Ellis Bay formation and again at Wreck beach in the Gun River formation. A single specimen was collected at the Jumpers in zone 9 of the Jupiter River formation.

The holotypes and paratypes are in Peabody Museum.

Superfamily, PENTAMERANA SCHUCHERT.
Genus, VIRGIANA *new genus*.
(Virgie, proper name.)

The generic name of Clorinda was proposed by Barrande for shells of which casts of the interior showed a series of strong ridges radiating from the umbonal ridge of the pedicle valve, these being produced by the vascular or ovarian sinuses. He stated that his two species were pentameroids not unlike *C. linguifera*. For this group Hall and Clarke proposed the generic name of *Barrandella*, the genus including shells which externally are moderately transverse, ventral valve the larger, moderately galeatiform, with a sinus on the ventral valve and a fold on the dorsal. In the Becsie River formation of the Anticosti section occurs the shell described by Billings as *Pentamerus barrandei* which in its young stages has all the characters of a true *Clorin-*

da. With maturity, however, the shell attains large size, becomes decidedly elongate, narrow, and pronouncedly galeatiform and the fold and sinus become reversed, the latter being obliterated and transformed into a fold by the development of an axial rib and the former disappearing through bifurcation of the initial fold producing a sinus at the margin. The interior is that of *Clorinda.*

For this type of clorindoid the generic name of *Virgiana* is proposed: the genus to include *V. barrendei*—the genotype—and two varieties of that species.

Order, PROTREMATA BEECHER.
Superfamily, RHYNCHONELLACEA SCHUCHERT.
Genus, CAMAROTOECHIA HALL AND CLARKE.
CAMAROTOECHIA DECEMPLICATA (SOWERBY).

1866. Rhynchonella Eva Billings, Cat. Sil. Foss. Anticosti, p. 44.
1871. Rhynchonella decemplicata Davidson, Mon. Brit. Foss. Brach., vol. iii, pt. vii, p. 177, pl. xxiii, figs. 20-24.
1900. Anabaia anticostiana Clarke, Archivos do Museu Nacional do Rio de Janeiro, vol. 10, 1899, Author's Eng. Ed., p. 15, pl. i, figs. 26-28.

This shell was described by Billings in 1866, as *Rhynchonella eva.* Subsequently (1900) Doctor John M. Clarke figured a specimen with a size somewhat above the norm, from the Shaler collection at Harvard. It came from East cliff, Anticosti, and had been collected by the Harvard expedition of 1861. This specimen Clarke was not able to identify with any of the descriptions of Billings and finding that it bore considerable resemblance to his *Anabaia paraia* from Brazil, he described it as *A. anticostiana.* A large series of specimens was collected at the type locality of both forms and from the descriptions of Billings and from specimens in the Victoria Memorial Museum, these were identified as *Rhynchonella eva.* They were also compared with the holotype of *A. anticostiana* and the two species were found to be identical. The genus *Anabaia* is spire bearing and is referred to the Coelospiridae. More than a dozen specimens of *R. eva* were studied by grinding and etching with hydrochloric acid and no traces of anything resembling

spires were seen although the preservation was such that traces of them were to be expected had they been present. On the contrary the internal structure is rhynchonelloid and as no vestige of a cardinal process appears to be present the species apparently is to be referred to the genus *Camarotoechia*. Through the kindness of Professor Johan Kiaer the writer was able to obtain specimens of *Rhynchonella decemplicata* from etage 6 (Zone, with *Rhynchonella 10-plicata*) of the Silurian Ringerike section of the Kristiana region and the identity of the two species was clearly shown. As the European name has priority by over twenty-five years, the American name must yield.

Horizon and Locality. Silurian; Gun River (4–5), Cape Sand Top bay, East cliff, and west of Jupiter river. In Norway the species is limited to Kiaer's zone c of etage 6, the topmost zone of the Lower Llandovery.

Anticosti plesiotypes of this species are in both the Victoria Memorial (No. 2449) and Peabody Museums.

Superfamily, TEREBRATULACEA WAAGEN.
Division, TEREBRATULOIDS SCHUCHERT.
Family, PROTOZEUGIDAE *new family*.

Primitive Terebratuloids with loops like that of *Magellania* but developing without metamorphosis. The shells are small, smooth, biconvex with the ventral valve subcarinate and the dorsal with a sinus.

PROTOZEUGA *new genus*.
(Protos, first; zeugos, a yoke).

1882. Waldheima Davidson, Suppl. Sil. Foss. Brach., p. 76.

This new genus is proposed to include a group of small Palæozoic brachiopods which constitute the oldest known terebratulids and which are characterized by the possession of a long loop similar to the matured structure seen in *Waldheimia* or *Magellania* to which these little shells have been erroneously referred.

Diagnosis of the Genus. Shells extremely small; generally longer than wide; anterior margin straight or reentrant; ventral valve very convex, subcarinate with a narrow median groove at the anterior margin; dorsal valve only slightly convex at the posterior end, but concave with a deep sinus at the anterior margin and in this sinus there may be a small rib; surface of both valves smooth. Dorsal hinge plate with a distinct cardinal process from which an elevated median ridge extends almost to the anterior margin. The crura are slender, short, almost horizontal, giving off two triangular crural apophyses which converge inward and ventralward almost to the point of meeting. The principal lamellæ extend forward to within a short distance of the front and are then reflected posteriorly to form the loop which is not angular, but uniformly curved; it rises above the primary lamellæ until its apex is on a level with the crural apophyses, having been reflected a distance equal to about half the length of the primary lamellæ. Shell structure plentifully, but not thickly punctate (this was demonstrated by treating the shell with hydrochloric acid and specimens so treated are studded with small needle-like elevations) Genotype *Waldheimia mawii* Davidson.

The matured loop of this genus is very like that of the final metamorphosed form as developed in *Waldheimia* or *Magellania*, but the resemblance is one of parallelism. In *Protozeuga* the loop develops direct and without metamorphosis in a way similar to that of the Devonian Centronellidae, while in *Waldheimia* or *Magellania* the mature loop is the final stage of a great series of developmental changes. This character and others given in the diagnosis show *Protozeuga* to be a primitive type of terebratulid whose systematic position is near the Centronellidae; but in a family distinct therefrom, the Protozeugidae. To this genus are referred *Waldheimia mawii; W.? glassii* Davidson, a somewhat larger form whose brachial apparatus has not yet been demonstrated, both from the upper Wenlock of Shropshire; *W. bicarinata* Angelin from Gotland, considered by Davidson as identical with *W. mawii; Protozeuga sulcomarginata* Savage from the Girardeau Limestone of Illinois and Missouri (Bull. Geol. Soc. Mo., vol. 24, p. 359, 1913); and the new species from Anticosti described as *Protozeuga anticostiana.*

PROTOZEUGA ANTICOSTIANA *new species.*
(Plate I, figures 8–10).

Shell very small, longitudinally pentagonal; anterior angles gently rounded, front straight; cardinal angles more abruptly rounded than anterior; cardinal slopes straight, meeting at about 90 degrees; an average specimen is 5 mm. long, 4 mm. wide, depth of both valves 2.25 mm., surface smooth; shell structure punctate as shown by etching with hydrochloric acid.

Ventral valve highly convex, deepest about one-third the length, keeled at the beak, toward the middle of the valve the keel widens out to a flat–topped fold which at the anterior margin is replaced by a sulcus; slopes to the lateral margins quite steep and at the cardinal angles the surface is slightly concave. Beak small, narrow, truncated by a small foramen, incurved and overarching the hinge line; no area.

Dorsal valve convex posteriorly and laterally, slightly depressed or concave just anterior to the hinge and divided into two lobes by a wide uniformly concave sulcus.

This shell closely resembles *Protozeuga mawii* (Davidson), but is slightly larger and proportionately wider. It occurs in much older strata and, while its brachial apparatus has not been demonstrated, its strong resemblance to the above species shows it to be congeneric.

Horizon and Locality. Ordovician; English Head (2–3), English head; Charleton (2–3), English bay and White cliff of the north shore.

The holotype and paratypes are in Peabody Museum.

Superfamily, SPIRIFERACEA WAAGEN.
Family, ATRYPIDAE GILL.
Subfamily, LISSATRYPINAE *new subfamily.*

Smooth atrypoids with the external aspect of *Nucleospira.*

Genus, LISSATRYPA *new genus.*
(Lissos, smooth; atrypa).

In 1866 Billings described from Gull cape (Wreck beach),

Anticosti, a smooth brachiopod to which he gave the name of *Athyris lara*. He called attention to the fact that some specimens have a faint indication of a mesial sinus in the ventral valve, but are generally without either fold or sinus.

In 1882 Davidson stated that Mr. Glass had been able to expose the spirals of *Athyris lara* and that these "entirely resemble those of *Atrypa*, the apex of each vertical cone being directed towards the middle of the bottom of the dorsal valve." These shells were collected by Doctor G. J. Hinde near Jupiter river and it is now known that they were not correctly identified.

Specimens of *Athyris lara* which were collected at the type locality and compared with the proterotypes show that it is a true meristellid and probably to be referred to the genus *Whitfieldia*. This leaves the shells whose structure was worked out by Mr. Glass without a name. The writer has also developed the internal structure of several of the Jupiter River shells and there is no question but that their spirals are of the atrypoid type. Externally they have the expression of *Nucleospira*, but lack the hirsute exterior. For atrypoids having these characters the generic name of *Lissatrypa* is proposed.

Diagnosis. Shell of medium size, lenticular, subovate or subpentagonal in outline, greatest width near the middle; both valves of nearly the same convexity, a faint sinus in some specimens at the anterior margin of the ventral valve, a corresponding small fold in the dorsal, in some specimens the anterior margin slightly linguate; hinge short, gently curved; no area; beak and umbones small, surface smooth with concentric lamellæ; shell structure fibrous and on exfoliation it has a silky sheen.

Beak of ventral valve closely incurved and in contact with the dorsal valve; foramen triangular, extending to the hinge line, no covering observed; teeth relatively large, diverging at an angle of about 135 degrees, summits rounded and curved slightly toward the centre of the shell; they rise from the lateral slopes of the interior and are unsupported by lamellæ; muscular impressions apparently very faint.

Dorsal valve with a faint sinus at the umbo; hinge plate composed of two diverging processes meeting at the apex at about 60 degrees; each has two longitudinal grooves dividing

it into three small ridges of unequal size of which the outer overhangs the dental sockets and ends abruptly and free; the inner ridges small. The middle ridges are slightly the longest and bear the crura which converge toward the dorsal valve for about one-sixth the length of the shell, where two knob-like crural apophyses are developed and almost come in contact. At the origin of these apophyses the primary lamallæ are abruptly recurved and develop the vertical spirals of which each has eight turns or less and has the apex directed toward the central area of the dorsal valve.

The genotype is *Lissatrypa atheroidea*, the specific name being selected to call attention to the fact that the shell resembles an *Athyris* (*Athyris;* oidos, like). According to Professor Schuchert (personal communication) *Atrypa phoca* (Salter) is also to be referred to this genus.

LISSATRYPA ATHEROIDEA *new species*.
(Athyris, oidos, like).
(Plate I, figures 11–15.)

1882. Athyris lara Davidson (not Billings), Suppl. Sil. Brach., p. 121.
1910. Nucleospira n. sp., Schuchert and Twenhofel, Bull. Geol. Soc. Am., vol. 21, p. 714.

Shell with the characters of the genus; width 14 mm.; length 14 mm.; depth of both valves 7 mm.

This shell is very apt to be mistaken for *Whitfieldia ? lara* (Billings), a mistake which has already been made. For final determination it is necessary to see the character of the spiral. *W.? lara*, however, has a somewhat more prominent ventral beak, is slightly larger, less often has the ventral sinus and dorsal fold and does not have a layered structure to the shell. These differences, however, can not be relied on, since there are many specimens which so far as external characters are concerned may be put in either species.

Horizon and Locality. Silurian; Gun River (5), about a mile west of Jupiter river; Jupiter River (3-5), mouth of Jupiter river.

The cotypes are in Peabody Museum.

Family, MERISTELLIDAE HALL AND CLARKE.
HYATTIDINA CHARLETONA *new species.*
(Plate I, figures 6-7.)

The single specimen upon which this species is based was discovered on a slab from Charleton point, the same slab containing *Phragmolites pannosa*, *Zygospira recurvirostra* n. var., and other Richmond fossils. Had it occurred in higher strata no hesitancy would have been felt in referring it to *H. congesta junea*, although it is somewhat smaller, proportionately longer, and has a small longitudinal groove on the dorsal fold which is not present in that species. The general shape is elongate ovate, the posterior outline being trigonal, the anterior two-thirds elliptical. The apical angle is about 110 degrees. Both valves are convex, the ventral slightly the more. The beak of the ventral valve is small, narrow, pointed at the apex, beneath which is a small foramen. A medium ridge, grooved toward the front, extends from the umbo to the anterior margin. From the depression bounding this ridge the surface slopes to the lateral margins. The dorsal valve is marked by three convex lobes of which the middle widens towards the margin and becomes divided by a longitudinal groove. No area has been seen on either valve. The shell is 4 mm. long, 3.5 mm. wide about mid length, and 1.25 mm. thick just in front of the umbo.

No hesitation is felt in referring this little shell to the genus *Hyattidina* though the interior has not been seen. This genus has hitherto in America not been found below the Clinton, but in England *Rhynchonella? portlockiana* Davidson [demonstrated by Reed to belong to the genus *Hyattidina* (Reed, Quar. Jour. Geol. Soc., 1897, p. 75)] ranges from the upper Llandeilo to the Bala; hence its appearance in American strata as early as the Richmond should occasion no surprise. It is further probable that *H. charleton* is a migrant from the British seas and is in the direct line of ancestry to *H. congesta*, since it chiefly differs from *H. portlockiana* in having the lateral slopes near the cardinal angles concave instead of convex, and Reed states that the latter differs from *H. congesta* only in the "presence of a short median septum in the brachial valve, and in the greater length of the process of the loop."

Horizon and Locality. Ordovician; Charleton (3), Charleton point.

The holotype and only known specimen is in Peabody Museum.

Phylum, ARTHROPODA.
Class, CRUSTACEA.
Subclass, TRILOBITA WALCH.
Order, OPISTHOPARIA BEECHER.
Family, OLENIDAE BURMEISTER.
Genus, TRIARTHURS GREEN.

TRIARTHRUS BECKI *var.* MACASTYENSIS *new variety.*

1910. Triarthus spinosus Schuchert and Twenhofel, Bull. Geol. Soc. Am., vol. 21, p. 694.

This new form is like *T. becki* except in one respect. The facial sutures are slightly more sinuous and in front they diverge from the axis instead of converging as in *T. becki.* The glabella of the most perfect specimen is 3.5 mm. wide; 4.5 mm. long; the entire cephalon 5 mm. long. That it grew to a larger size is proven by a specimen which has the cephalon at least 8 mm. long. The same type of facial suture is seen in the *T. becki* from the Collingwood black shale of Ottawa, Canada, and Doctor Ruedeman has called the writer's attention to the fact that *T. jemtlandicus* Lindstrom has a similar facial suture, though otherwise different.

Horizon and Locality. Ordovician; evidently present in considerable abundance in the Macasty black shales.

The holotype and a single paratype are in Peabody Museum.

The first number of the Museum Bulletin was entitled, *Victoria Memorial Museum Bulletin Number 1.*

The following articles of the Geological Series of Museum Bulletins have been issued.

Geological Series.

1. The Trenton crinoid, Ottawacrinus, W. R. Billings; by F. A. Bather.
2. Note on Merocrinus, Walcott; by F. A. Bather.
3. The occurrence of Helodont teeth at Roche Miette and vicinity, Alberta; by L. M. Lambe.
4. Notes on Cyclocystoides; by P. E. Raymond.
5. Notes on some new and old Trilobites in the Victoria Memorial Museum; by P. E. Raymond.
6. Description of some new Asaphidæ; by P. E. Raymond.
7. Two new species of Tetradium; by P. E. Raymond.
8. Revision of the species which have been referred to the genus Bathyurus (preliminary paper); by P. E. Raymond.
9. A new Brachiopod from the base of the Utica; by A. E. Wilson.
10. A new genus of dicotyledonous plant from the Tertiary of Kettle river, British Columbia; by W. J. Wilson.
11. A new species of Lepidostrobus; by W. J. Wilson.
12. Prehnite from Adams sound, Admiralty inlet, Baffin island, Franklin; by R. A. A. Johnston.
13. The origin of granite (micropegmatite) in the Purcell sills; by S. J. Schofield.
14. Columnar structure in limestone; by E. M. Kindle.
15. Supposed evidences of subsidence of the coast of New Brunswick within modern time; by J. W. Goldthwait.
16. The Pre-Cambrian (Beltian) of southeastern British Columbia and their correlation; by S. J. Schofield.
17. Early Cambrian stratigraphy in the North American Cordillera, with discussion of the Albertella and related faunas; by Lancaster D. Burling.
18. A preliminary study of the variations of the plications of Parastrophia hemiplicata, Hall; by Alice E. Wilson.